Ames Construction, Inc.®

Larpenteur Avenue Bridge Slide

I-35E MnPASS Design-Build Project
S.P. 6280-367
Federal Project No. I35E(003)

July 9-10, 2014

Table of Contents

LARPENTEUR BRIDGE SLIDE
Lessons Learned
(All photos can be found in the attached appendices)

FALSEWORK

Summary

- The Larpenteur Avenue Bridge located over I-35E Interstate in Maplewood, MN was proposed to be designed and constructed using an Accelerated Bridge Construction (ABC) technique known as a bridge slide. For the bridge slide, temporary construction falsework was designed and fabricated using steel H-piles and cap plates. The falsework and slide tables were designed by Michael Baker, Jr. Corporation and may be found in the attached appendices. Upon design approval, Ames contracted with Triad Metals (Columbia City, Indiana) to supply and fabricate the falsework tables. After some initial fabrication delays, Ames personnel self-performed a portion of the falsework table fabrication on-site.

- Pile driving for the center pier falsework table started March 8th, 2014. The order of installation for the falsework table piles was Larpenteur center pier, east abutment, and then west abutment. The order of installation for the slide tables was Larpenteur east abutment, center pier, and then the west abutment. The overall duration of the falsework table installation lasted nearly one month. All sub-cap and slide table welds were completed by April 17th, 2014. The crew size for the slide table installation consisted of four Ames personnel (1 operator, 3 pile drivers).

- The pier and abutment diaphragm construction process used for this bridge was similar to that of conventional methods. After the slide table installation was complete, Ames shot survey at each of the proposed beam seats for the Larpenteur Bridge superstructure. Ames personnel then began to form the beam seats for the superstructure's girders. Using the elevations shot from survey, we adjusted the height of each formed beam seat to meet the proposed design. The duration for forming and pouring each beam seat was approximately (2) days.

Observations/Suggestions:

- Re-design the slide table to reduce the amount of field welding. The design called for welds that were approximately 8 foot long in some locations. All of this extra time spent welding hindered production that could have been obtained elsewhere in the field.
- The piles and materials used for the slide table were readily available. This allowed Ames personnel to receive the materials as needed and complete the falsework installation at a faster, more productive rate.
- Re-design the center pier slide table connection to the permanent center pier structure. As seen on the following page, the pier cap was poured against the slide table and any deflection in the slidetable was directly transferred to the pier cap. This caused damage to the edge of the concrete pier cap prior to sliding the bridge.

Falsework Figure 1, 2, & 3 - Pier Cap/Falsework Joint (Damaged Concrete)

- Reconfigure the connections of the slide tables to the abutments. These were difficult to remove post-slide.

Falsework Connection Figure 3 & 4

BRIDGE SLIDE EXECUTION

- Crew Size & Location:
  - (1) Lead Jacking Engineer/ Pump Operator (Master Pump/Center Pier Jack Float)
  - (2) Jacking Engineers (Abutment Jack Floats)
  - (4) Slide Track Tenders (Abutment/Pier Slide Tables)

Pre-Slide / Pre-Planning

- The bridge with formwork and false deck weighed over 4 million pounds (based on number of jacks and pressure gauge indicators). Original estimates were in the range of 3.8 million pounds.
- Pre-slide verification against design proved to be critical. This includes all elements of the slide including substructure, superstructure, fabricated slide system and falsework. The smallest error or deviation can lead to significant problems and/or rework. In most circumstances, bridge moves similar to this will need to be conducted within tight timeframes. This means that the operation needs to be functioning at the highest, most efficient level. This can only be attained through a very thorough pre-planning checklist and verification process.

- Suggestions/Observations:
  - Better contingency planning
    - Having the vertical jacks staged where needed would have saved some time
    - What would we have done if we were unable to utilize the wingwall / steering jack to bring the bridge back on alignment?
  - Slide Table – Verify slide table elevations post loading.
    - In trying to determine why the superstructure favored traveling west, one thought is that the western slide table was lower than the other slide table elevations. Was this caused by post superstructure loading on the temporary bent or during installation of the slide table? In the future, during pre-slide assembly, we may need to shim between the embedded plate and slide surface. We should have plywood or steel shims on hand to accomplish this.
  - Clearly identify the stopping point of the slide, procedure to correct/adjust within the last few feet of the slide. Endo should be indicated at all critical locations, as well as centerline. The identification of these points should be discussed and verified with the tenders prior to the slide.
  - After fabrication of the slide table(s), survey each beam seat location on the slide table. After pouring each substructure unit, survey each beam location in its permanent location. Provide shims as necessary for final bearing placement.
  - Have a pre-approved bearing shim plan and materials on hand so that they could be placed immediately following the slide.

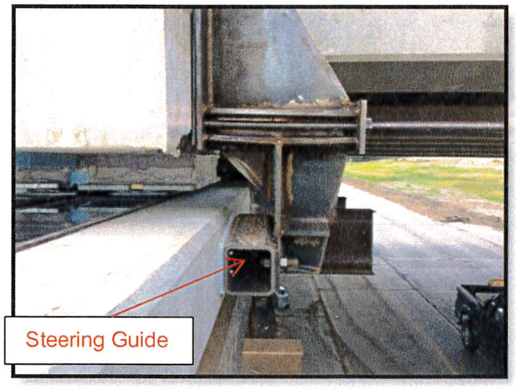
Sliding Operations:

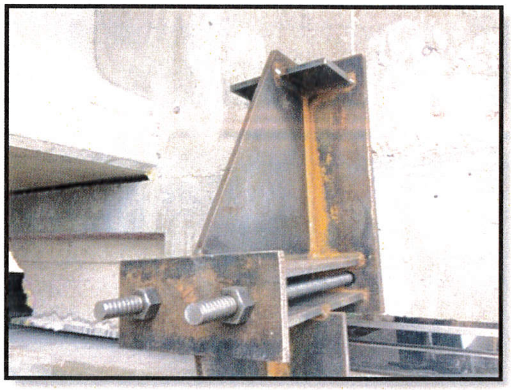
- As the bridge slide progressed, the slide plate assemblies were moved from the North end of the slide track to the South end by the slide tenders. Each Jacking Engineer was tasked with communicating to the Lead Jacking Engineer/Pump Operator how far each cylinder has been extended or retracted in each stroke cycle.
- At the start of the last slide iteration, personnel were stationed at the geometric control points to advise the Jacking Engineers of the remaining distance the bridge needed to slide to get to its final destination.

Post-Slide Operations:

- Following the bridge slide, the jacks were re-installed and the superstructure was jacked up in order to remove the slide shoes and slide assemblies. After the slide shoes and slide assemblies were removed, the permanent neoprene bearings were installed prior to lowering the superstructure onto the permanent substructure.

- Suggestions/Observations:
    - Use liquid detergent, or compatible agent, to reduce friction. This should be used sparingly so as to not create (reduce) friction between some of the other slide material.
    - Tight tolerances between the diaphragms, dog plates, and jack float guides caused binding in the slide system. Construction tolerances must be considered when designing, fabricating and constructing the slide system components. Quality control is very critical during these steps.
    - The guide brackets proved to be inadequate. Ultimately we realized that they were undersized and needed better connection to the diaphragm. There was too much binding and racking. If used again, we need to reduce friction in the steering mechanism much like that of the slide surface.



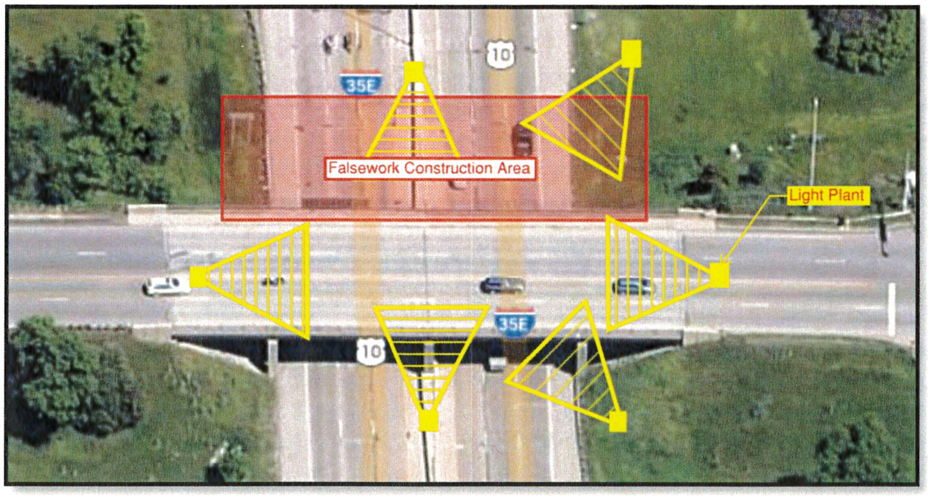


Center Pier Guide 1 & 2

- It was a good decision to go with a single, larger pump. This proved to be faster and more efficient than what the smaller two pump system was advertised to be.
- Overall, once the bugs were worked out, the slide system performed very well. Based on the results of the second night, the system proved to be very quick and efficient, moving the final 30 ft. +/- in less than two hours.
- Anchor/Secure/Fabricate the sliding shoes to the object/structure (see attached sketches). The only way the Teflon and steel stayed together was through friction. In the event that friction was lost (i.e. too much lubricating agent), we had no alternative other than to stop the operation and lift the superstructure in order to replace the faulty item.
- Increase the thickness of the Teflon, allowing it to curl around the rubber bearing keeping soap out of that joint. Spare Teflon sheets should be on-hand to replace the damaged ones, if needed.
- On the second night we opted to use UHMW (ultra high molecular weight) as a back-up rather than Teflon. The UHMW has a sliding coefficient 25% greater than that of Teflon and we can say that it performed very well. It also illustrated much better abrasion characteristics and seemed more durable.
- There needs to be a thicker elastic medium between the slide shoe and bridge to allow for the deviations in concrete and steel elevations. The plywood we installed after the fact helped, but once crushed, would not rebound sufficiently. Recommendation would be to double the thickness of the temporary neoprene bearing. With that said, plywood would work well as a bearing with minimal/small undulations in the slide table.
- Vertical jacking should be performed as soon as slide is complete to allow for remainder of work to progress without interfering with any necessary bridge adjustments.

Safety

- Pre-activity meetings should be held each night to discuss procedure, safe work practices, and communication. At these designated meetings, we should review roles, responsibilities and contingency options for the planned work.
- There were a lack of tie off points and safety platforms for the guys who were operating, monitoring and maintaining the slide system. Tie- off points need to be 1) incorporated into the design of the bridge/slide system or 2) added during the installation of the slide system. Walkways need to be provided, reducing the need for aerial lifts. This would expedite work in and around the slide shoes, including any required vertical jacking. These work platforms would also assist with fall protection issue discussed in the previous bullet.
- We could have used better lighting at the critical areas. It seemed like all three push jack locations were poorly lit. Likewise, the leading edge of the center pier was also dark. We did have decent lighting on the deck and at the abutments. Additionally, headlamps should be provided for the tenders. The main lighting utilized for the slide included (6) - portable light plants positioned around the bridge as shown on the following page.



Light Plant Layout - Bridge Slide

Communication

- Radio communication between those in control of the bridge slide mechanism and those at critical observation areas proved to be very important. We quickly recognized the benefit of having a designated lead person at each abutment or pier that can communicate directly to the person controlling the bridge slide. These individuals must understand the criticalness of alignment, pressures and what to watch for with regards to the jacking system (i.e. persons involved with both design and implementation of the bridge slide). This was missing on the test run but it appeared to be established the following two nights. Furthermore, establishing hold points and what to watch for need to be determined ahead of time.

Media

- It was good to have an observation area where spectators and the media could gather. The area that we designated for all media observation was on each side of the bridge's abutments and positioned far enough back so that any observation did not interfere with the slide operations. See diaphragm below for reference.

- Having a designated MnDOT Public Relations person available to communicate with the media was helpful.

- Capturing the bridge slide thru use of video and still photography was a great decision. We've received positive feedback from the time-lapse video that was created from the images. The video will be a great promotional advertisement for future ABC conducted by both MnDOT and Ames Construction.